Remarks

Affirmation of the election of Group I, claims 1-22 and withdrawal of Group II, claims 23-28 is affirmed.

The Examiner did not indicate on the Office Action Summary whether the formal drawings filed with the application were accepted or objected to. Therefore, Applicant assumes they are acceptable.

Claims 1-22 and 29 are currently pending. Claims 23-28 have been withdrawn and claim 29 has been added. Claims 1-5, 8-10, and 13-17 have been amended.

Claims 2-4 were rejected under 35 U.S.C. 112 as being indefinite. The Examiner found the language "scale factor" and "measure of structure" to be indefinite. Claim 2 has been amended to make the rejection moot.

Claims 1 and 10-11 were rejected under 35 U.S.C. 102(b) as being anticipated by Sato et al. (US 5,428,483). Claim 12 was rejected under 35 U.S.C. 103(a) as being unpatentable over Sato et al. Claim 2-4 were rejected under 35 U.S.C. 103(a) as being unpatentable over Sato et al. in view of Pollatta et al. (US 5,554,430). Claim 8-9 and 14-15 were rejected under 35 U.S.C. 103(a) as being unpatentable over Sato et al. in view of Pollatta et al. in further view of Weeks, Jr. et al. (US 5,834,115). Claim 5-7 and 16-19 were rejected under 35 U.S.C. 103(a) as being unpatentable over Sato et al. in view of Yadav (US 6,228,904).

Currently amended independent claims 1, 13 and 17 and new claim 29 each define a fiber reinforced substrate having fibers arranged in a coarse structural pattern or weave. As explained in the Related Art section, CTE, modulus, strength and stress mismatch between the fiber material and the matrix material within the substrate would cause "print through" of the coarse texture to the optical

surface. For example, the CTE of graphite fiber is about negative 1.0ppm/C in the direction of the fiber axis and about positive 22ppm/C perpendicular to the fiber axis. The carbon in a matrix is about 4ppm/C. Since the carbon matrix can match only one of the CTE's of the substrate, the matrix alone can not solve the print through problem.

In accordance with the invention, the mirror includes a fiber reinforcement layer in which submicron diameter fibers are arranged in a fine structure. The "fineness" of the fiber reinforcement in this layer serves to diffuse, disperse and randomize the coarse texture of the underlying weave or pattern from printing through to the optical surface. Furthermore, because this layer is formed from "submicron diameter" fibers, it does not itself create another pattern that would noticeably print through to the optical surface and reflective optical coating.

The Sato, Pollatta, Weeks and Yadav references do not teach nor suggest the claimed mirror structure. Furthermore, there is no suggestion in any of these references to combine their respective teachings to form a fiber reinforcement layer as claimed to diffuse print through from a fiber reinforced substrate to the optical surface. Lastly, assuming the teachings were combined they would not yield the claimed structure. The elimination of "print through" in fiber reinforced mirrors is a longstanding and troublesome problem, which is effectively and uniquely solved by Applicant's invention.

Sato teaches "An reflecting mirror includes a first substrate consisting of a carbon fiber-reinforced plastics, a reflecting layer formed on the front surface of the first substrate, a second substrate formed on the rear surface of the first substrate, an edge member formed at edges of the

first and second substrates, and a foamed body filled in a spaced defined by the first and second substrates and the edge member." (Summary) The second substrate preferably also consists of a carbon fiber-reinforced plastics (CFRP). "The carbon fiber-reinforced plastic substrate can be machined like glass to allow a reflecting layer to be formed thereon. Since the reflecting layer is formed on the front surface of the carbon fiber-reinforced plastic surface, the overall of the reflecting mirror obtained is very light." (Summary). Based on Sato's description of the CFRP substrates, both the 1st and 2nd substrates would have internal CTE and stress mismatches on a scale that would "print through" the fiber structure to the reflecting layer. There is no suggestion that the 1st substrate exhibits a relatively fine structure to diffuse any print through nor is it formed from submicron diameter fibers. Furthermore, it is found in widespread actual practice that machining or polishing the CFRP substrate, which is pseudo-isotropic, to form the reflecting layer produces a very poor quality optical surface due to a fuzz of dangling cut fibers that are vastly stronger than the matrix and partially pull loose as they are cut, which creates a carpet like surface. The quality is so poor that print through from the CFRP substrate would be unnoticeable, hence there would be no motivation to modify the mirror to overcome an undetectable problem. The rejections of claims 1, 20-11 and 12 are respectively traversed.

Pollatta teaches a boron/carbon fiber 1D laminate comprising a boron fiber layer and a carbon fiber layer. Typically, the fiber and amount of fiber is selected to meet stiffness, weight and cost criteria and the resulting CTE is accepted. Pollatta provides additional capability

to specify CTE while maintaining maximal stiffness for that CTE. As the Examiner notes Pollatta specifies Boron fibers of 75 to 140 micron diameters and that Carbon fibers having diameters of 8-12 microns are well known (Handbook of Composites). Pollatta's 1D laminate may diffuse structure from the Boron fiber layer from printing through to the reflecting layer but does nothing to inhibit the still coarse structure in the Carbon fiber layer from printing through to the reflecting layer and corrupting the quality of the optical surface. If one were to combine the teachings of Pollatta with Sato, one could design a lightweight, inexpensive reflective mirror with a selectable CTE. However, the mirror would include no structure to diffuse print through from the substrate, albeit unnoticeable due to a less than optical quality surface finish. Therefore, claims 1 and 13 are patentable in view of the teachings and any suggested combination of Sato and Pollatta.

Claim 2 as currently amended further specifies that the "first and second fibers have substantially the same coefficient of thermal expansion (CTE)". In general, the fibers in the fiber reinforcement layer are suitably selected to approximately match the CTE and stress properties of the substrate to avoid inducing mismatch problems (p. 3, lines 14-16). Clearly, Pollatta's Boron/Carbon laminate intentionally have substantially different CTEs in order to control the macroscopic CTE of the entire mirror.

Claim 3 as currently amended further specifies that the fibers in the substrate are bundled into tows and woven into a cloth having a first scale factor. The fine structure of the fibers in the reinforcement layer have a

second scale factor at least an order of magnitude less than the first scale factor. Although Pollatta uses Boron fibers whose diameter is more than an order of magnitude greater than the diameters of standard Carbon fibers, it does not necessarily follow that the scale factors of the arrangements of the Boron and Carbon fibers have the claimed relationship. The density of the fibers required to combine Boron's positive CTE and Carbon's negative CTE to achieve a desired overall CTE and a high stiffness could produce a wide variety of scale factor relationships. The issue is simply not relevant to Pollatta and not addressed. Accordingly, the rejection of claim 3 is traversed.

Claim 4 as currently amended specifies an initial optical surface quality of no worse than 10 nm RMS and a maintained surface quality of no worse than 15nm RMS, neither of which are suggested or obtainable by the cited combination. Accordingly, the rejection of claim 4 is traversed.

The Examiner uses the Weeks reference to establish that a metallic substrate may be reinforced with woven graphitic fibers. As acknowledged in the Related Art section of Applicant's application, it is this woven pattern that is used to reinforce the substrate that is causing the long felt and unresolved problem of print through. The "untowed weave" recited in claim 8 of submicron diameter fibers defines a fine structure sufficient to diffuse print through. The "towed weave" in which each tow includes less than 200 fibers recited in claim 9 similarly defines such a fine structure. Contrary to the Examiner's assertion, these fine weaves useful for print through diffusion provide little in the way of

"greater dimensional stability". Accordingly, the rejections of claims 8-9 and 14-15 are traversed.

The Examiner uses the Yadav reference to provide a basis for the use of "namometric scale reinforcement filler". Yadav's broad ranging patent addresses placing one of many nanoparticles in one of many matrices for a wide variety of reasons including carbon black in tire rubber, intermetalics in heat treatment strengthened metal alloys, oxide particles in dispersion strengthened metals, carbon nanotubes in polymers, and pigments in paints. There is absolutely no suggestion that one take these nanoparticles and bind them in the matrix of a fiber reinforced mirror to diffuse the print through of the underlying fiber structure. A vague notion that nanotube reinforced composites may provide some unspecified enhancement of mechanical, thermal, electric or other properties does not in any way obviate the specific novelty of combining submicron fibers in a layer above a fiber reinforced substrate to diffuse print through.

Furthermore, the Examiner correctly takes the position that the nanoparticle filler has a random orientation throughout the composite. In other words the particles are random in three dimensions. To preserve the integrity of the optical surface the fiber reinforced layer must be relatively thin. The "fine structure" of the submicron diameter fibers (or nanoparticles) does not provide the requisite stiffness in a thick layer. However, nanoparticles that are random in three-dimensions will not diffuse print through in such a thin layer. To the extent that fibers are random in only two-dimensions, i.e. horizontal within a layer as described and claimed by Applicant, they reduce the tendency of the surface to

follow the shape of the strong stiff weave in the substrate. The inclusion of fibers that are vertically oriented counteracts the desired effect of the horizontal fibers and tends to make the layer follow the underlying weave.

Throughout the claims the submicron diameter fibers are arranged within a layer such as, for example, a mat, cloth or very fine weave. As described in the application and shown in Figures 4a through 4c, the submicron diameter fibers may, for example be "randomized throughout the layer" (Fig. 4a), a weave of single or finely towed fibers (Fig. 4b), or a mat (Fib. 4c). Each arrangement is two-dimensional within the layer and thus is capable of diffusing print through in a sufficiently thin layer to maintain the integrity of the optical surface. Accordingly, the rejection of claims 5-7 and 16-19 is respectfully traversed. Furthermore, claims 1, 13 and 29 are not obvious in view of the suggested combination of Sato and Yadav.

Allowable Subject Matter

Claims 20-22 were allowed.

Conclusion

It is respectfully urged that the subject application is patentable over the cited references and is now in condition for allowance.

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Respectfully submitted,

Thomas J. Finn
Reg. No. 48,066
520 794-7980 Phone

Date: August 11, 2005

ATTORNEY FOR APPLICANTS